(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 047 803**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **80200862.3**

(51) Int. Cl.³: **E 02 F 3/92**

(22) Date of filing: **12.09.80**

(43) Date of publication of application:
24.03.82 Bulletin 82/12

(84) Designated Contracting States:
BE DE FR GB IT SE

(71) Applicant: **Dosbouw**
Havenplateau
Westerschouwen Burghsluis(NL)

(72) Inventor: **Bakker, Adriaan Daniel**
Noordweg 56
Serooskerke(NL)

(72) Inventor: **Wolters, Tjako Aaldrik**
Sanatoriumlaan 4
Zeist(NL)

(74) Representative: **Konings, Lucien Marie Cornelis Joseph et al,**
OCTROOIBUREAU ARNOLD & SIEDSMA Sweelinckplein 1
NL-2517 GK Den Haag(NL)

(54) **Method and suction dredging device for sucking up dredging spoil.**

(57) Dredgings which, in suction operation, are sucked up by means of a suction head, comprising a flexible wall (4), so that the suction head is adjusted in dependence on a pressure difference between the pressure P1 of a suspension stream (10) and the pressure P2 prevailing in the ambient water (51).

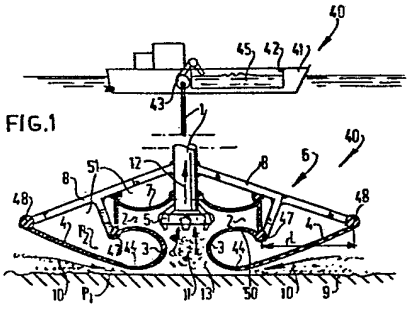


FIG.1

EP 0 047 803 A1

Method of and suction dredger for sucking up dredgings.

The invention relates to a method of sucking up dredgings from subaqueous ground, wherein a suspension stream of dredgings and water is sucked up by means of a suction head and a dredgings transport conduit connected with the former and provided with pump means and wherein at least one suction-head lower rim connected by means of at least one flexible suction-head wall with the dredgings transport conduit is held at a level matchig the ground level.

Such a method is known from German patent specification 1,634,724. In this known method the suction head is connected with the aid of bellow-shaped, suction-head steel parts with the suction-head rim working the ground in order to transmit the vibrations produced by way of said bellow--shaped suction-head steel parts to the ground for working the same.

The invention provides a method of readily lifting dredgings and/or material to be eroded by a water stream from the ground and has for its object to reduce in-flow losses. To this end the method according to the invention is characterized in that the shape of the flexible suction-head wall is adjusted in dependence on a pressure difference between the pressure of the suspension stream locally flowing along the flexible suction-head wall and the pressure prevailing on

the side of the flexible suction-head wall remote from the suspension stream.

For using such a suction head on a bottom which must not or substantially not be affected by suction-head parts a further developed method is characterized in that the flexible suction-head wall is adjusted with respect to the bottom by setting the level of a frame carrying the flexible suction-head wall with respect to the dredgings transport conduit.

In order to reduce still further the flow resistance in the suction head to the entrance of the dredgings transport conduit a further developed method is characterized in that a flow profile of the flexible suction-head wall is adjusted by fastening the flexible suction-head wall to at least two relatively spaced fastening elements, the length of the flexible suction-head wall in the working state exceeding the distance between the two fastening elements and in that a pressure difference is created along substantially the whole length of the flexible suction-head wall between the higher pressure of the ambient water and a lower pressure on the side of the flexible suction-head wall remote from the ambient water.

When working a bottom wave movements or the like may result in vertical movements in the suspension construction of the dredgings transport conduit giving rise to a pump effect in the suction head which disturbs the dredging process.

A preferred method further developed in this respect is characterized in that the flexible suction-head wall is set in a form of skate-shaped cross-section by arranging the two fastening elements on the same side at different distances from the dredgings transport conduit, whilst between the fastening element nearest the dredgings transport conduit and the dredgings transport conduit there is arranged a control-chamber in which substantially the same pressure is maintained as in the dredgings transport conduit and/or in the suction head and in that the shape of the flexible suction-head wall is determined via a flexible outer wall, via the

control-chamber as well as via the flexible suction-head wall also in dependence on the higher pressure of the ambient water.

The invention furthermore relates to and provides a device for carrying out the method according to the invention. This device for sucking up dredgings from subaqueous ground comprising a suction head and a dredgings transport conduit connected with the former and provided with pump means, said suction head having at least one suction-head lower rim which is level-variably connected by means of at least one flexible suction-head wall with the dredgings transport conduit is characterized in that the shape of the flexible suction-head wall is adjustable in dependence on a pressure difference between the pressure of a suspension stream locally flowing along the flexible suction-head wall and the pressure prevailing on the side of the flexible suction-head wall remote from the suspension stream.

Since in the case of a great length of the flexible suction-head wall it is not inconceivable that this wall might be sucked by the suction force into the dredgings transport conduit, a further development of the device according to the invention is characterized in that the flexible suction-head wall is less deformable near the inlet of the dredgings transport conduit than the further part of the flexible suction-head wall.

Such a sucking-in effect is furthermore avoided and a reasonably satisfactory guidance of the flow near the inlet of the dredgings transport conduit is ensured in a preferred device designed to this end, which is characterized in that on the side remote from the suspension stream the flexible suction-head wall is fastened to inhibiting elements connected with fastening elements of the frame of the suction head, said inhibiting elements holding the flexible suction-head wall within a maximum distance with respect to said fastening elements.

In particular, the invention provides an improvement in a suction head moved along the bottom and having a large working width transverse of the direction of displacement of the suction head and being intended for sucking up

material which has been fluidized in advance or which is found in the fluidized form on the bottom. This device according to the invention is characterized in that - viewed in the direction of movement of the suction head along the bottom - the suction head comprises a flexible suction-head wall preceding the entrance of the dredgings transport conduit.

If dredgings in a more or less compact state have to be lifted by the broad suction head, this suction head is improved in this respect in that with the aid of water-jet nozzles arranged on the suction-head frame the ground material is loosened by the jets in a region lying in front of and/or above the flexible suction-head wall - viewed in the direction of movement of the suction head.

According to the invention a device for sucking up dredgings from subaqueous ground is improved in that - viewed in the direction of movement of the suction head - a suction-head rim preferably comprising a flexible element and co-operating in closing relationship with the bottom is provided on the front side of the entrance of the dredgings transport conduit, whilst the flexible suction-head wall is arranged downstream of the entrance.

In order to obtain a most accurate adjustment of the suction gap and a most economic erosion of the ground surface in the layer to be worked a further, preferred device is characterized in that a rim of the flexible suction-head wall remote from the entrance of the dredgings transport conduit is connected with a bottom support, which is level-variably connected with the dredgings transport conduit.

It should be noted that it is known per se in using fluid jets under the water level to use flexible walls in order to screen off the region of utilisation of the fluid jets from the ambient water.

Such a method and device are known from Dutch patent application 7211568 laid up for public inspection.

The above-mentioned and further features of the invention will be set out more fully in the following description with reference to a drawing of some vertical sectional views.

The drawing shows in:

Figure 1 a device in accordance with the invention,

Figure 2 a variant of the suction head of the device of Figure 1,

Figure 3 a simple variant of a suction head having control-means in accordance with the invention,

Figure 4 a suction head particularly suitable for a large working width,

Figure 5 a suction head constructed in the form of a drag head in accordance with the invention,

Figures 6 and 7 each a variant of the suction head of Figure 2,

Figure 8 a guide structure for accurately joining a rear rim provided with a flexible suction-head wall for a suction head already provided at the front with a flexible suction-head wall to the ground,

Figures 9, 10 and 11 a suction head constructed in the form of a drag head having a ground support and a flexible suction-head wall in different working positions,

Figure 12 an enlarged sectional view taken on the line XII-XII in Figure 9,

Figure 13 an enlarged sectional view taken on the line XIII-XIII in Figure 9,

Figures 14 and 15 variants of details of the drag head of Figures 9 to 13, and

Figures 16, 17 and 18 further variants of a drag head in accordance with the invention.

An arrangement 40 according to the invention comprising, as shown in Figure 1, on a reduced scale, a vessel 41 having a hold 42 for receiving dredgings 45 furthermore comprises a suction head 6 and a dredgings transport conduit 1 connected with the former and provided with a pump 43, said suction head 6 having a suction-head lower rim 44, which is connected by means of a flexible suction-head wall 4 with the dredgings transport conduit 1. The flexible suction-head wall 4 may consist of an annular collar of rubber or similar, elastic, wear-resistant material, the length of which in the cross-sectional view shown appreciably exceeds the distance $\underline{l}$ between the connecting elements 47 and 48 arranged at dif-

ferent distances from the dredgings transport conduit 1 or on the frame 8 so that in the operative position of the flexible suction-head wall 4 the cross-section has the shape of a skate, whilst a beading 3 of said flexible suction-head wall 4 defines a suction chamber 13. As shown in Figure 1, the frame 8 is rigidly secured to the dredgings transport conduit 1. The shape of the flexible suction-head wall 4 is adjustable in dependence on a pressure difference between the pressure P_1 of a suspension stream 10 locally flowing along the flexible suction-head wall 4 and the pressure P_2 prevailing in the ambient water 51 on the side of the flexible suction-head wall 4 remote from the suspension stream 10. Because the flexible suction-head wall 4 has a great freedom of setting itself automatically, an advantageous form of flow of low flow resistance is obtained. The term "suspension stream" is to be understood to mean the stream of slush, water and/or a mixture of water and ground material sucked up by the suction head 6.

The dredgings transport conduit 1, through which a suspension stream 10 is conducted away at a rate 12 exceeding, as a matter of course, the critical rate of the grains contained in the suspension 11, joins the suction chamber 13 of the suction head 6, into which flows a suspension 11 at a comparatively low rate. In order to avoid settling of grains water jet nozzles 5 are arranged in the suction chamber 13 for keeping the suspension 11 moving.

The flexible suction-head wall 4 approaches the bottom 9 at vertical movements of the dredgings transport conduit 1, but it does not or substantially not touch the bottom 9. During these upward and downward movements part of the contents of the suction chamber 13 would be pumped to and fro so that the dredging process would be interrupted. In order to avoid this effect an annular control-chamber 2 having a flexible outer wall 7 adjacent the suction chamber 13 is provided, said chamber alternately receiving and delivering part of the contents of the suction chamber 13. This control-chamber 2 is arranged between an annular connecting element 47 and the dredgings transport conduit 1 and is boun-

ded by the top side 50 of the beading 3 of the flexible suction-head wall 4 and the flexible outer wall 7, which separates the control-chamber 2 from the ambient water 51. This control-chamber 2 communicates with the dredgings transport conduit 1 and/or with the suction chamber 13.

The suction head 2 of Figure 2 has a smaller suction chamber 13 so that a higher rate of transport 12 of the suspension 11 is obtained, which prevents grains from settling down. The flexible suction-head wall 4 moves by its inwardly extending beading 3 along the outer side of the dredgings transport conduit 1. Therefore, the suspension 11 to be conducted away at the rate 12 has adequate velocity 14 in the suction chamber 13 and the inlet 21 for preventing settling of the grains. The dredgings transport conduit 1 communicates through orifices 29 provided therein with the control-chamber 2 so that in said chamber 2 prevails the same or substantially the same pressure as in the dredgings transport conduit 1. The shape of the flexible suction-head wall 4 is adjusted in dependence on the condition of the ambient water 51 via the outer wall 7 and the control-chamber 2.

It should be noted that although the suction head 6 of Figures 1 and 2 is described in the foregoing as being annular, it is preferred to construct the suction head 6, as is shown in Figure 3 with two suction-head walls 4 and 54 arranged each on one side of the inlet of the suction chamber 13 and having a substantially identical shape along a given suction width of the suction head 6. The suction head 6 of Figure 3 furthermore differs from that shown in Figures 1 and 2 in that the frame 8 carrying the flexible suction-head walls 4 and 54 is level-variably adjustable with respect to the dredgings transport conduit 1 by means of hydraulic rams 52 controlled on board the vessel 41 and in that said flexible suction-head walls 4 and 54 each have a fairly flexible outer portion 20 and an adjacent, less flexible portion 19 near the inlet 21. In this way the flexible suction-head wall 4, 54 is prevented from partially entering the inlet 21 by suction force and from thus partly clogging the inlet 21. The shape of the flexible suction-head walls 4 and 54 can fur-

thermore be acted upon by pressurized fluid chambers 23 to be pumped up from a distance as shown in Figure 3. By chosing different pressures in the pressure chambers 23 independently of one another through separate air ducts 55, the suspension stream 10 can flow optionally through the inlet 24 or through the inlet 25.

A suction head 6 further developed in this respect is illustrated in Figure 4, in which fastening elements 48 of separate frames 8 and 18 respectively are arranged at a high and a low level respectively so that a suspension stream 10 can enter the suction chamber 13 only through an inlet 24. In this case dredgings 28 lying on a ground 9 are caused to form a suspension with the aid of water jets 26 and 27 respectively and conducted away through the inlet 24, the suction chamber 13 and the dredgings conveying conduit 1, whilst the flexible suction-head wall 54 lying on the ground 9 ensures local closure. In this way, for example, sand 16 collected on a foundation mat 15 can be removed, whilst, if necessary, the suction head 6 is displaced in the direction indicated by the arrow 56.

Figure 5 shows a suction head 6 according to the invention, which forms part of a drag head 37 dragged along the bottom 9 in the direction indicated by the arrow 57. The drag head 37 bears on the bottom 9 by a heel rim 34 and the dredgings transport conduit constructed in the form of a drag pipe 33 is connected with the vessel 41. Near the inlet 21 of the drag pipe 33 a flexible suction-head wall 30 is provided at the fastening area 32 and carried on its rear side by a frame 31 of the drag head 37. The frame 31 bears by means of skids 36 on the bottom 9 in an adjustable manner. Owing to the low pressure P_1 obtained by means of the pump 43 in the suction chamber 13 with respect to the pressure P_2 of the ambient water 51 and by the level setting of the skids 36 with respect to the frame 31 by means of setting members 58 a suction gap $\underline{s}$ is formed in which the dredgings on the bottom 9 are readily eroded by the high erosion rate and are conducted away in the suspension stream 10 through the drag pipe 33. The setting members 58 may be formed by an adjustable

bolt-hole joint.

The suction head 6 of Figure 6 has at least one flexible suction-head wall 4, which is fastened on its side remote from the suspension stream 10 at the areas 62 to inhibiting elements 60 formed by stay wires connected with fastening elements 61 of the frame 8, said inhibiting elements 60 holding the flexible suction-head wall 4 within the maximum distance corresponding to the length of the stay wires with respect to said fastening elements 61 in order to avoid undesirable deformation of the suction-head wall 4. The suction head 6 is indicated by broken lines and designated by reference numerals with an apostrophe at a higher level with respect to the bottom 9. If the rate of displacement of the water 51 with respect to the suction head 6 or conversely is so high the water tends to press the suction-head wall 4 to an excessive extent into the suction gap s, a barrier plate 85 shown in Figure 6 is used for enhancing the pressure P_2.

Figure 7 shows a variant of Figure 6 with a flexible suction-head wall 4, whose undesirable, inadmissible deformation is inhibited by a comparatively rigid portion 19 of large wall thickness, which is guided by the outer side of the dredgings transport conduit 1 and a guide element 63 rigidly secured to the frame 8.

The drag head 37 of Figure 8 comprises a flexible suction-head wall 54, which is fastened to a pivotable frame 68, which is pivotable about a pivotal axis 69 between a cutting position indicated by solid lines and a non-cutting position indicated by broken lines and designated by reference numerals with apostrophe. The frame 68 carries a knife 70, which works the bottom 9 in the cutting position and cuts loose dredgings 28. In the non-cutting position the flexible suction-head wall 54 is in its working position 54'. The knife 70 is only used for leaving a smooth bottom behind.

The drag head 37 of Figures 9 to 11 comprises a flexible suction-head wall 4, the outer rim of which is fastened to fastening elements 47 and 48 connected with a frame 8, which is pivotable about a horizontal shaft 71 and which bears on the bottom 9 through lateral skids 49 in order

to hold the lower rim 44 of the suction head formed by the lower part of the flexible suction-head wall 4 at a distance of the gap s for the erosion of the bottom 9. Figure 10 shows the drag head 37 of Figure 9 at a greater suction depth and Figure 11 shows that a large stone 59 can be sucked up with a matching deformation of the suction-head wall 4, whilst in a normal situation the suspension stream 10 has a narrow passage along a long trajectory 17 and even at the entrance 21.

According to the invention the suction-head wall 4 has to be flexible in the flow direction of the suspension stream 10, but transverse thereof it may be rigid. As shown in Figure 12 the suction-head wall 4 consists of a skin 39 having reinforcing ribs 38 extending in a transverse direction. The suction-head wall 4 is displaceable and joins in a water-tight manner side cheeks 35 of the frame 8 and side walls 46 of the drag pipe 33 by means of sealing tongues 22.

Figure 13 shows that a tongue 22 engages in sealing relationship an exploring rim 67 of the side wall 46 and the side cheek 35.

In the variant shown in Figures 14 and 15 of the drag head 37 of Figures 9 to 12 the lateral skids 49 are replaced by end skids 36 and lateral flow guides 53 consisting of a flexible strip of skate-shaped profile, the length of which exceeds the distance m between the fastening areas 65 and 66.

The drag head 37 of Figure 16 is distinguished from that of Figure 9 in that the beading 3 is provided with a flow guide strip 73 having a pressure-equalizing opening 72, the free rim 74 of which is held in contact with the top wall 75 of the drag pipe 33.

Figure 17 shows a further development of the drag head 37 of Figure 5 in which the flexible suction-head wall 4 is fixed between a fastening member 48 on the outer rim 77 and a fastening member 47 engaging the inner rim 78 of the suction-head wall 4, said fastening member 47 being arranged in a displaceable manner with respect to he drag pipe 33 by pivotably connecting the same by means of a pivotal bar 79 on a shaft 80 with the drag pipe 33 and by means of a pivotal

rod 81 about a shaft 82 with the frame 8. The fastening member 47 is rigidly secured to the pivotal rod 79 and the pivotal rod 79 is pivotable with respect to the pivotal rod 81 by means of a hinge 83. In this way the inner rim 78 is guided along an arcuate path in the drag pipe 33 and the effective length of the flexible suction-head wall 4 is adapted to the angular turn of the frame 8 with respect to the drag pipe 33, whilst the inlet 21 and the gap width s substantially maintain their passage. The inhibiting elements 60 operate herein in the same manner as the inhibiting elements 60 of Figure 9. The pivotal rod 81 has a setting member 84 for adjusting its length. The flexible suction-head wall 4 is preferably made of a skin of elastic material having a rigidity increasing from the outer rim 77 towards the inner rim 78.

The drag head 37 of Figure 18 comprises a flexible suction-head wall 4, whose inner rim 78 is rigidly connected with the top wall 75 of the drag pipe 33 and whose outer rim 77 is slidably bearing on the frame 8. Viewed in a direction away from the part of the suction-head wall 4 located near the outer rim 77, the rigidity in the direction of flow is materially greater than that of the part of the suction-head wall 4 bounding the inlet 21 and being held in the desired form by means of the inhibiting elements 60.

CLAIMS

1. A method of sucking up dredgings from subaqueous ground, wherein a suspension stream of dredgings and water is sucked up by means of a suction head and a dredgings transport conduit connected with the former and provided with pump means and wherein at least one suction-head lower rim connected by means of at least one flexible suction-head wall with the dredgings transport conduit is held at a level matchig the ground level, characterized in that the shape of the flexible suction-head wall is adjusted in dependence on a pressure difference between the pressure of the suspension stream locally flowing along the flexible suction-head wall and the pressure prevailing on the side of the flexible suction-head wall remote from the suspension stream.

2. A method as claimed in claim 1 characterized in that the flexible suction-head wall is adjusted with respect to the bottom by setting the level of a frame carrying the flexible suction-head wall with respect to the dredgings transport conduit.

3. A method as claimed in claim 1 or 2 characterized in that a flow profile of the flexible suction-head wall is adjusted by fastening the flexible suction-head wall

to at least two relatively spaced fastening elements, the length of the flexible suction-head wall in the working state exceeding the distance between the two fastening elements and in that a pressure difference is created along substantially the whole length of the flexible suction-head wall between the higher pressure of the ambient water and a lower pressure on the side of the flexible suction-head wall remote from the ambient water.

4. A method as claimed in claim 3 characterized in that the flexible suction-head wall is set in a form of skate-shaped cross-section by arranging the two fastening elements on the same side at different distances from the dredgings transport conduit, whilst between the fastening element nearest the dredgings transport conduit and the dredgings transport conduit there is arranged a control-chamber in which substantially the same pressure is maintained as in the dredgings transport conduit and/or in the suction head and in that the shape of the flexible suction-head wall is determined via a flexible outer wall, via the control-chamber as well as via the flexible suction-head wall also in dependence on the higher pressure of the ambient water.

5. A device for sucking up dredgings from subaqueous ground comprising a suction head and a dredgings transport conduit connected with the former and provided with pump means, said suction head having at least one suction-head lower rim which is level-variably connected by means of at least one flexible suction-head wall with the dredgings transport conduit, characterized in that the shape of the flexible suction-head wall (4) is adjustable in dependence on a pressure difference (P_2-P_1) between the pressure (P_1) of a suspension stream (10) locally flowing along the flexible suction-head wall (4) and the pressure (P_2) prevailing on the side of the flexible suction-head wall (4) remote from the suspension stream (10).

6. A device as claimed in claim 5 characterized in that a frame carrying the flexible suction-head wall is level-variably adjustable by setting means with respect to the dredgings transport conduit.

7. A device as claimed in claim 5 or 6 characterized in that for fastening each flexible suction-head wall at least two fastening elements are provided on the frame of the suction head (6) at different distances from the dredgings transport conduit, the distance (1) between the two fastening elements for the flexible suction-head wall (4) being smaller than the length of the flexible suction-head wall (4) lying between them in the working state.

8. A device as claimed in anyone of claims 5 to 7 characterized in that between the fastening element (47) nearest the dredgings transport conduit (1) and the dredgings transport conduit (1) there is arranged a control-chamber (2)bounded by a flexible outer wall separating the control--chamber (2) from the ambient water and by the flexible suction-head wall (4), the control-chamber (2) communicating with the dredgings transport conduit (1) and/or a suction chamber of the suction head (6).

9. A device as claimed in anyone of claims 5 to 8 characterized in that the flexible suction-head wall (4) is less deformable near the inlet of the dredgings transport conduit (1) than the further part of the flexible suction--head wall (4).

10. A device as claimed in anyone of claims 5 to 9 characterized in that on the side remote from the suspension stream (10) the flexible suction-head wall (4) is fastened to inhibiting elements (60) connected with fastening elements of the frame of the suction head (6), said inhibiting elements (60) holding the flexible suction-head wall (4) within a maximum distance with respect to said fastening elements.

11. A device as claimed in anyone of claims 5 to 10 characterized in that - viewed in the direction of movement of the suction head along the bottom - the suction head comprises a flexible suction-head wall preceding the entrance of the dredgings transport conduit.

12. A device as claimed in anyone of claims 5 to 11 characterized in that - viewed in the direction of movement of the suction head - a suction-head rim preferably comprising a flexible element and co-operating in closing relation-

ship with the bottom is provided on the front side of the entrance of the dredgings transport conduit, whilst the flexible suction-head wall is arranged downstream of the entrance (Figure 5).

13. A device as claimed in anyone of claims 5 to 11 characterized in that - viewed in the direction of movement of the suction head - a suction-head rim preferably comprising a flexible element and co-operating in closing relationship with the bottom is arranged on the rear side of the entrance of the dredgings transport conduit, whilst the flexible suction-head wall is disposed on the front side of said entrance (Figure 4).

14. A device as claimed in anyone of claims 5 to 13 characterized in that a rim of the flexible suction-head wall remote from the entrance of the dredgings transport conduit is connected with a bottom support, which is level-variably connected with the dredgings transport conduit (Figures 5 and 10).

FIG.1

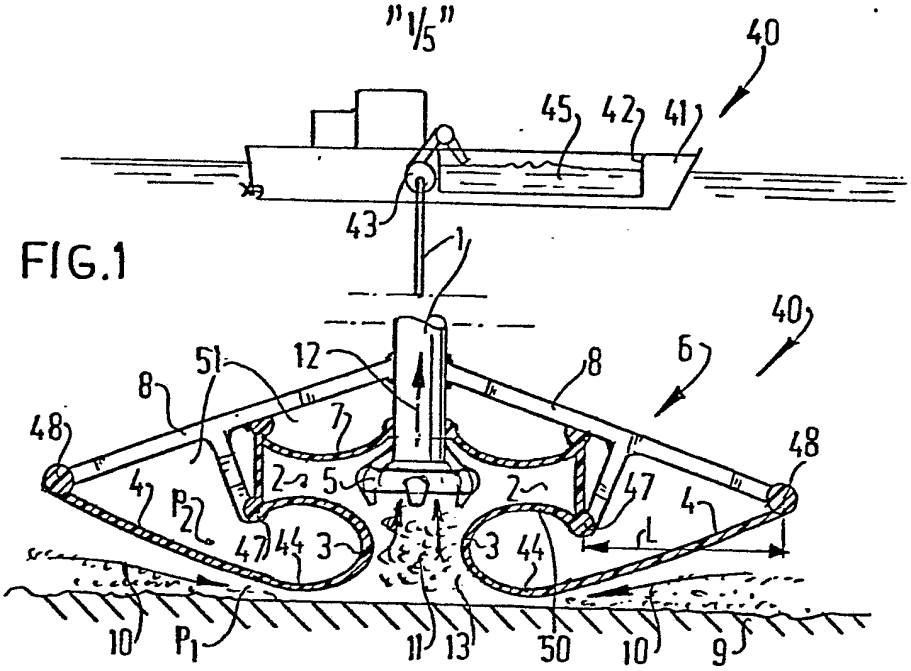


FIG.2

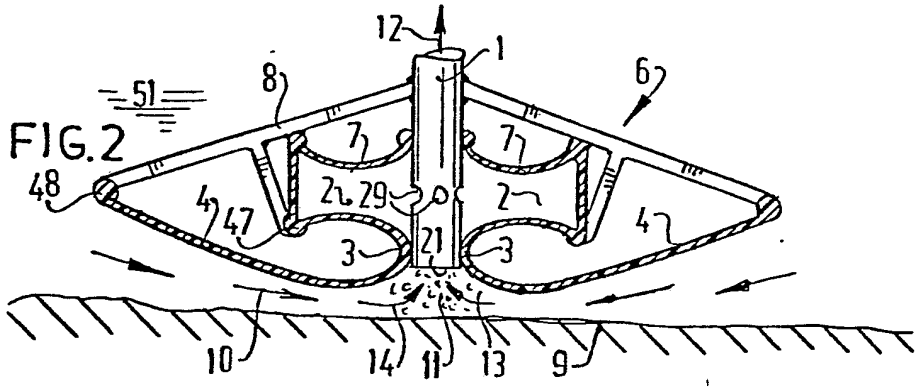
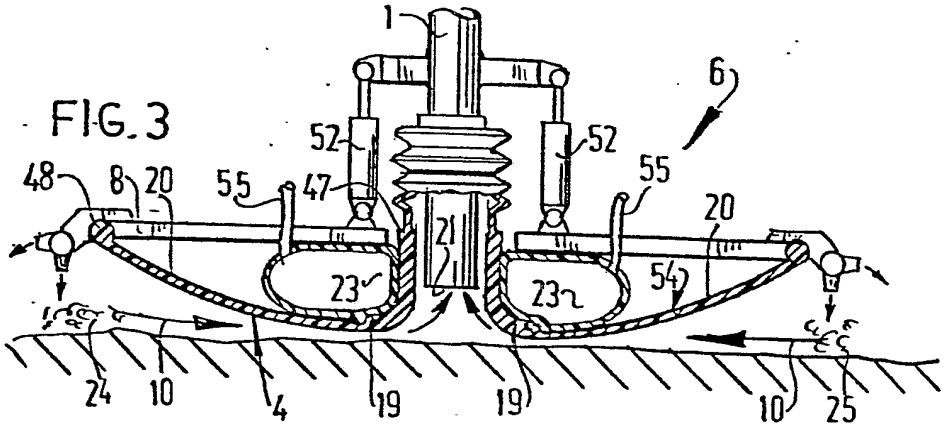


FIG.3



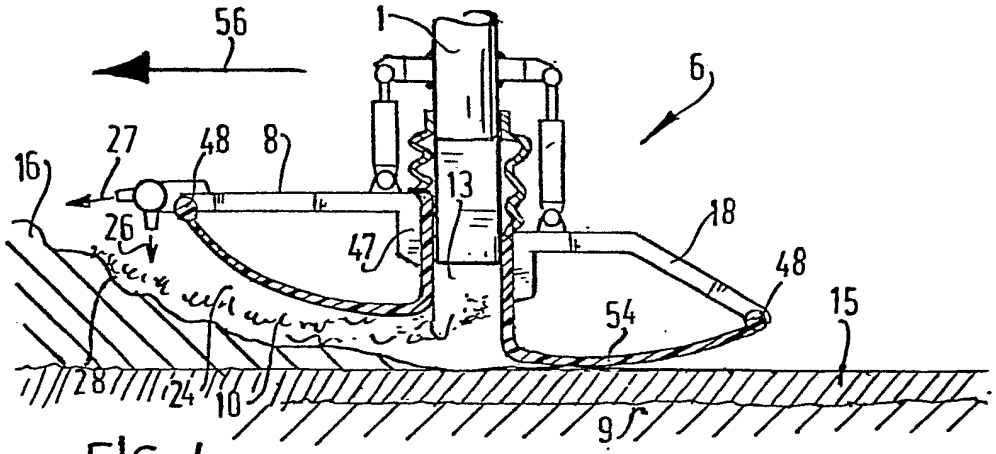


FIG. 4

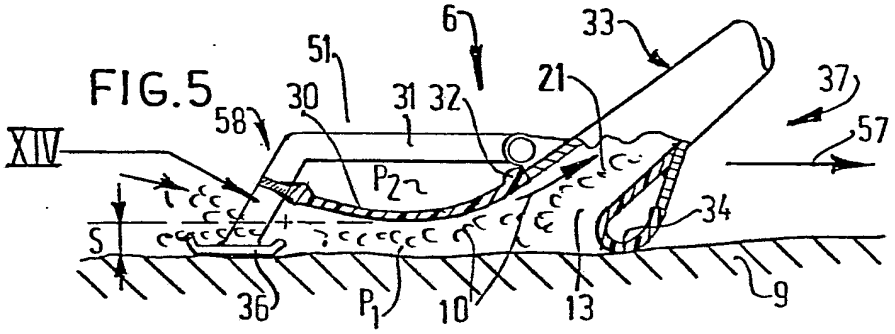


FIG. 5

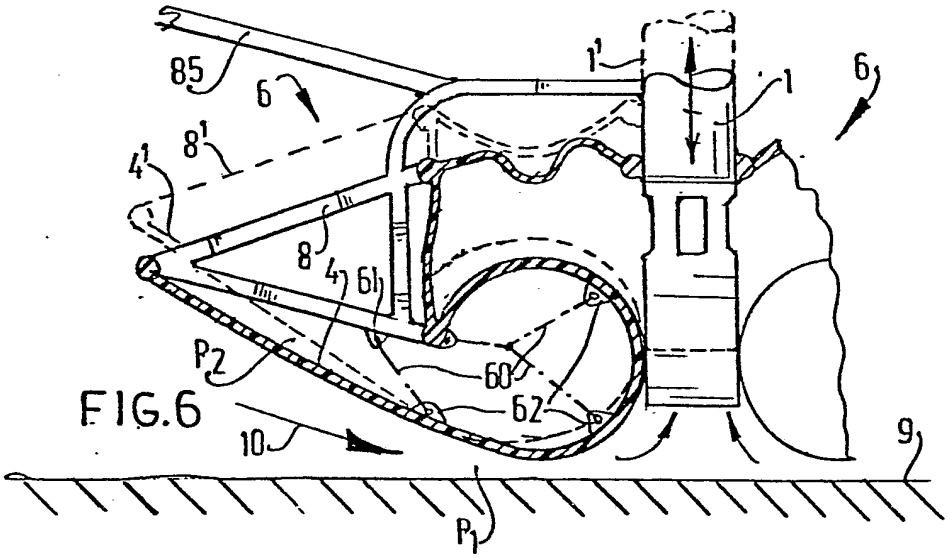


FIG. 6

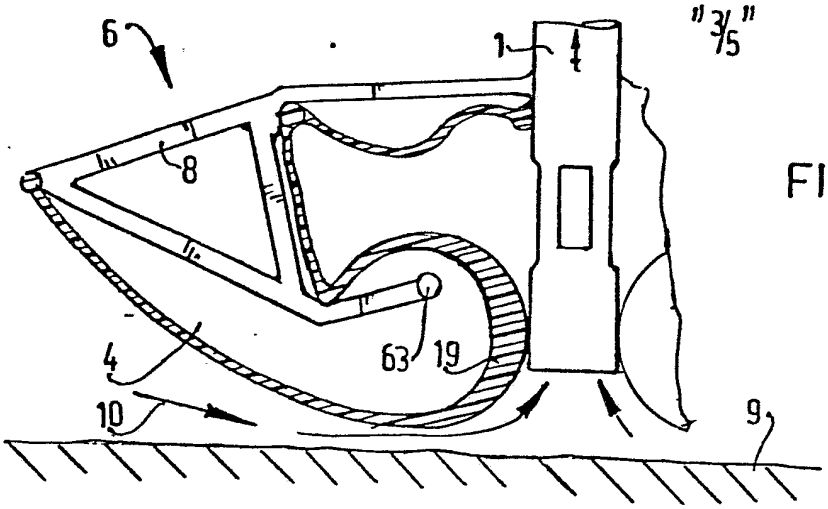


FIG. 7

FIG. 8

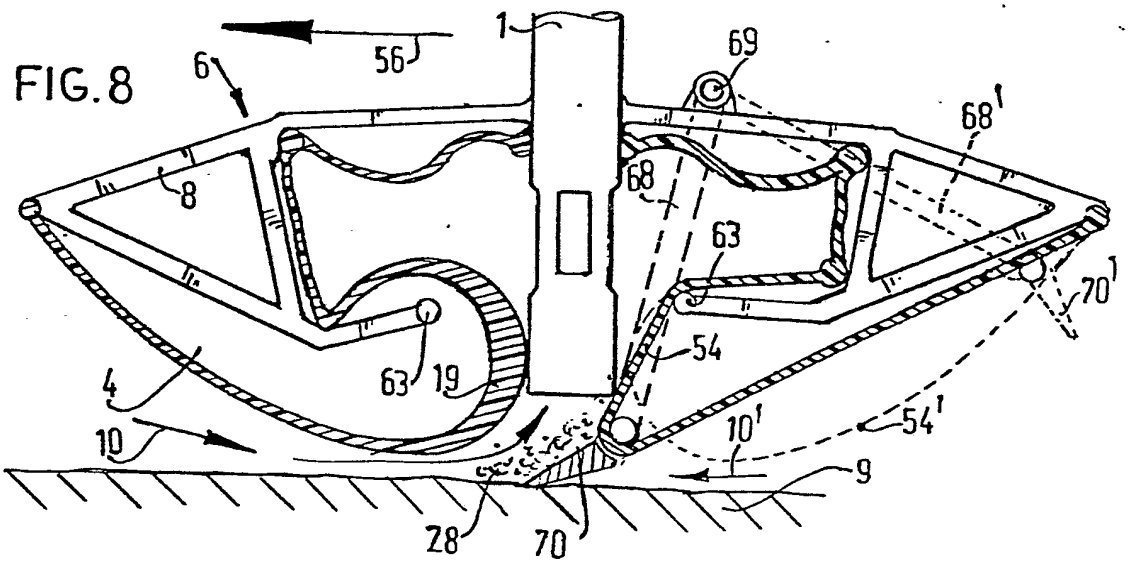
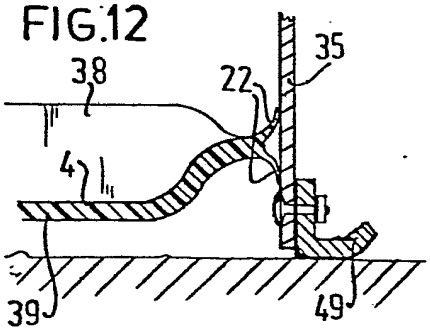


FIG.12



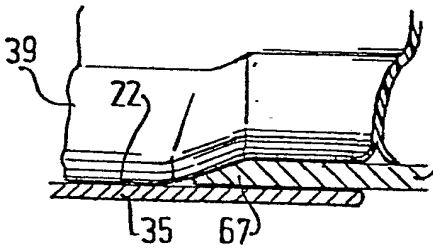


FIG.13

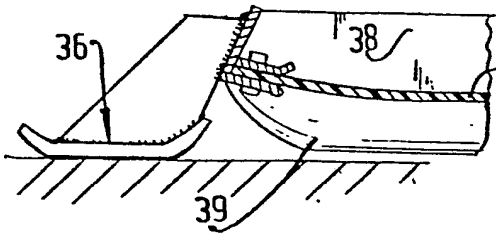


FIG.14

FIG.15

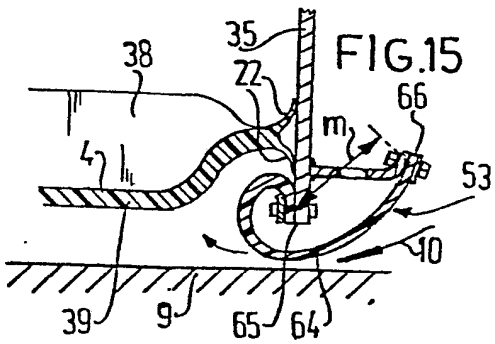


FIG.9

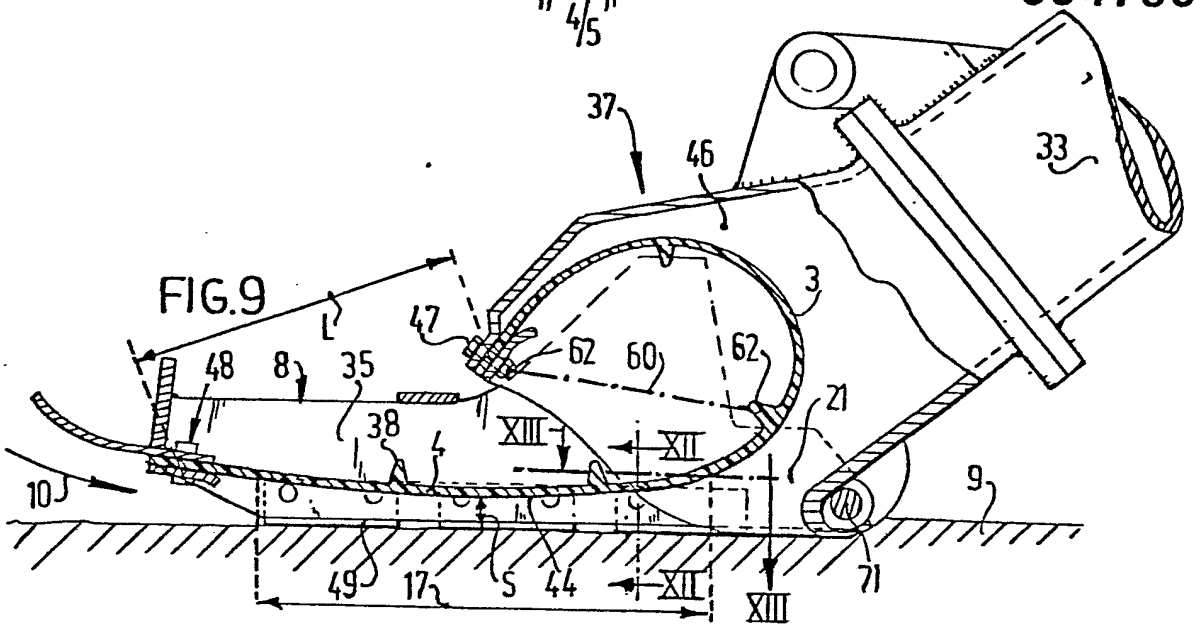


FIG.10

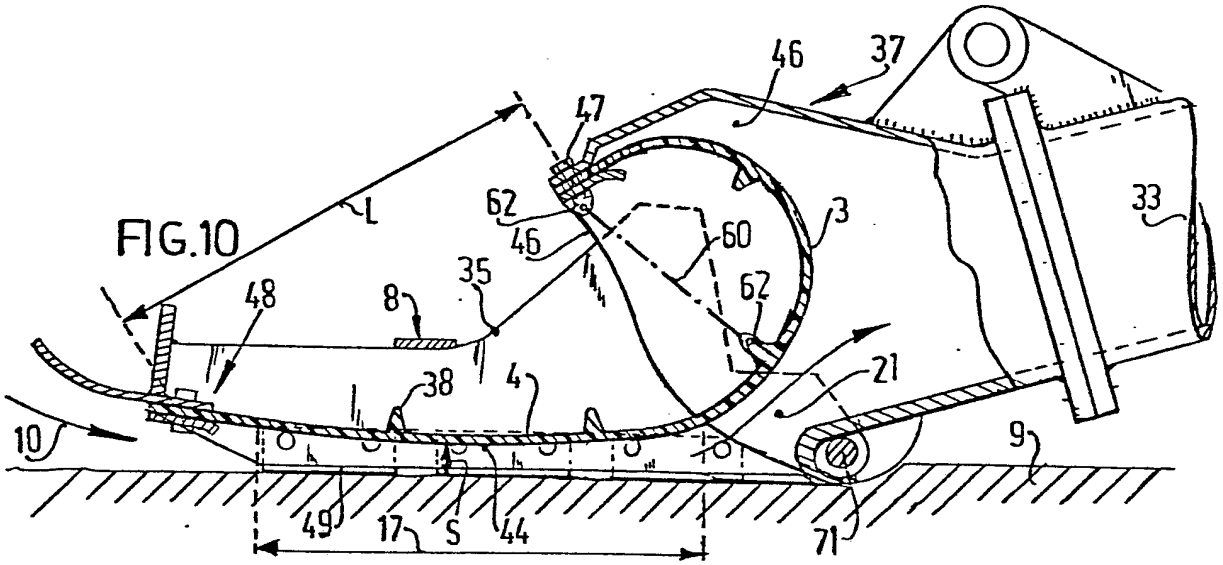


FIG.11

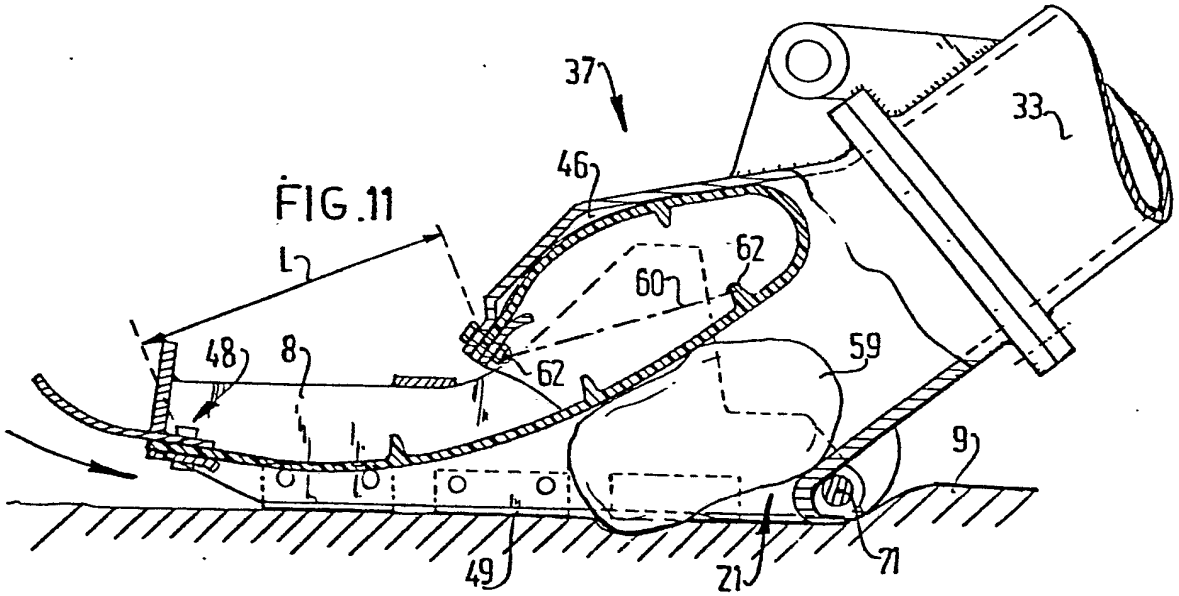


FIG.16

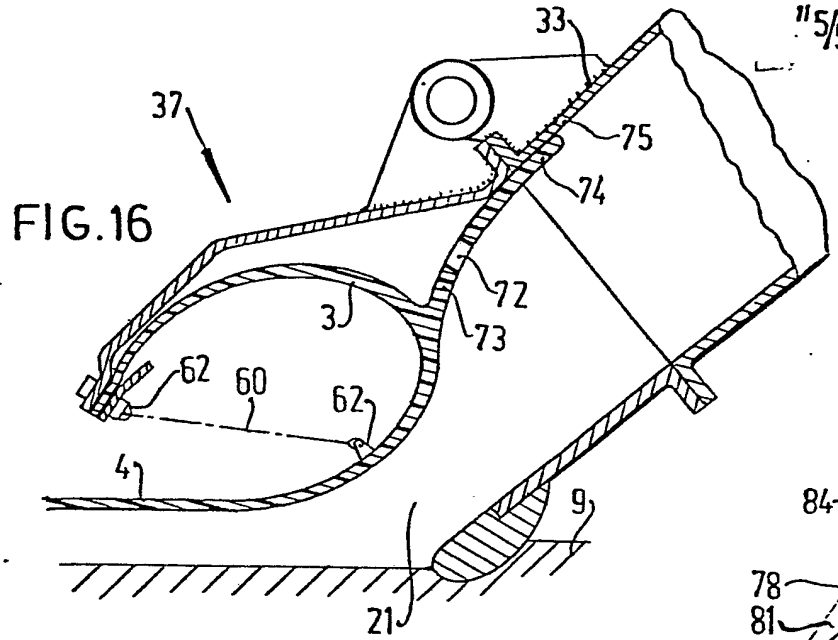


FIG.17

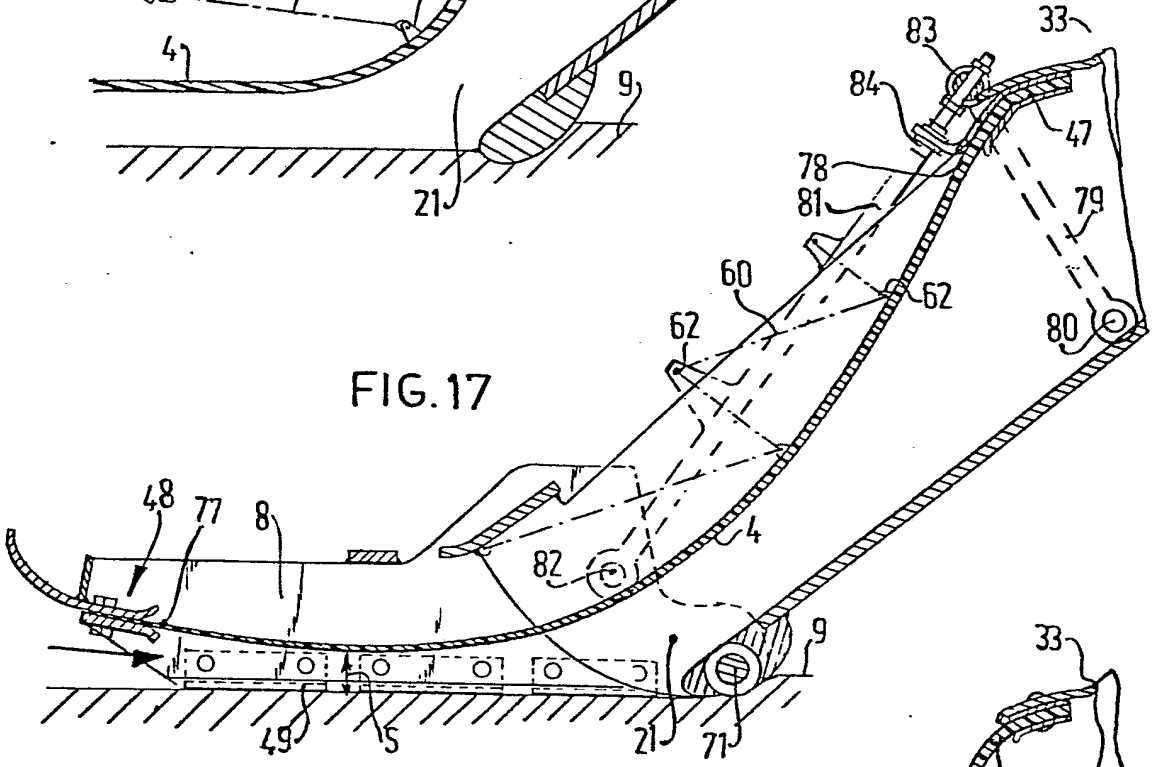
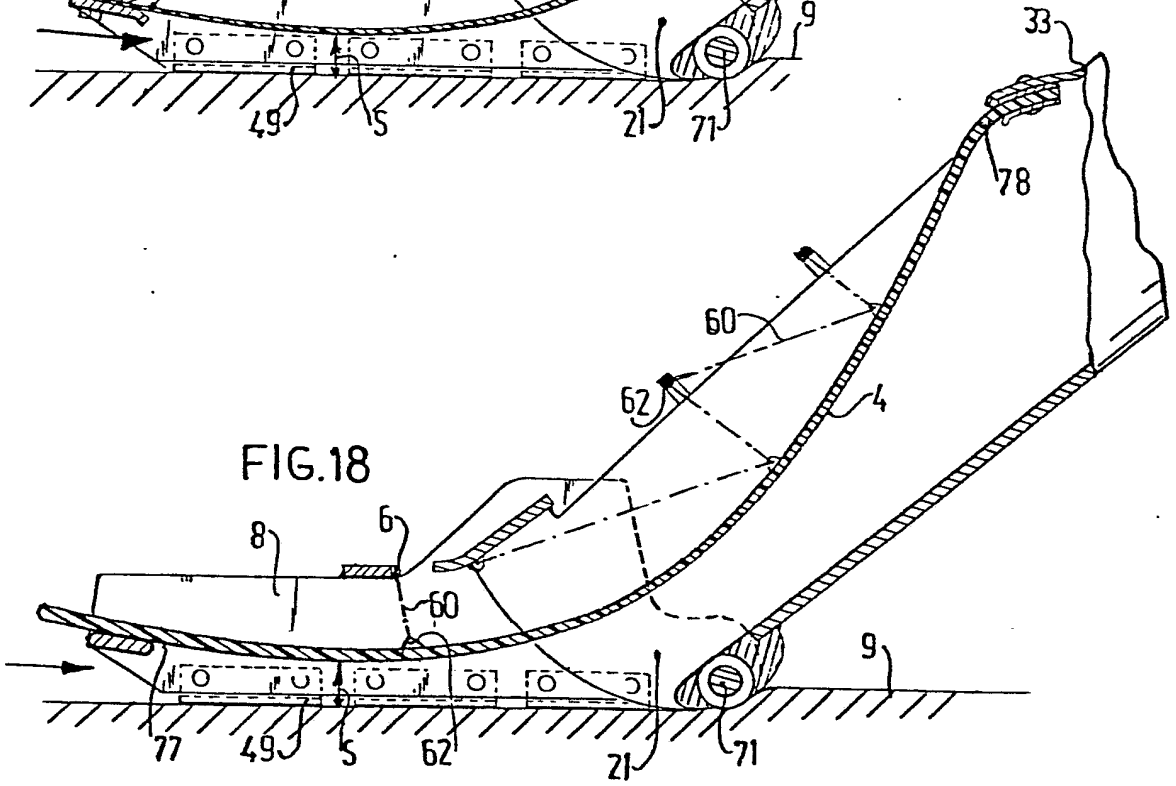


FIG.18



European Patent Office

0047803

Application number
EP 80 20 0862

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	DE - A - 1 928 417 (ORENSTEIN) * Page 3, paragraph 2; page 4 to page 5, paragraph 3; figures 1-3 * & GB - A - 1 309 438	1,3,4,8
D	NL - A - 72 115 568 (HYDRONAUTICS) * Page 8, line 10 to page 9, line 11; figure 3 * & GB - A - 1 379 942	12
	FR - A - 2 074 565 (REGIE AUTONOME DES TRANSPORTS PARISIENS) * Page 2, lines 5-27; claim 4; figure 2 *	6,11-13
A	GB - A - 1 060 825 (JOHNSTON)	
A	US - A - 4 053 181 (NAKAJI)	
A	US - A - 3 975 842 (ANDREAE)	
A	US - A - 1 840 606 (SCHEFFAUER)	
D/A	DE - A - 1 634 724 (BODINE) * Figures 1 and 4 *	

CLASSIFICATION OF THE APPLICATION (Int Cl.³)

E 02 F 3/92

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

E 02 F
E 21 C
B 65 G
E 01 H

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18.05.1981	PAUCNIK